COMPUTERS AND OUR FUTURE

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1. INTRODUCTORY REMARKS

- What will be the impact of computing machines on our society 10, 20, 40 years from now?

- How will the expanding use of computers change the structure of society and our individual lives?

These questions raise further questions:

- What can be done to analyze and extrapolate into the future so as to predict the future impact of computing machines?

- What can be done toward evaluating the social and moral implications wrought by the computer?

- What actions might be taken to modify and alter some of the possible consequences?

The purpose of these brief notes is <u>not</u> to answer the above questions, but rather to see what would be required in order to attack and answer them systematically. This exercise will raise more questions than can be answered, but we can clarify the problems of computers and our future only by raising and examining the related questions. This is all part of a still larger problem; viz., what is the

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nature of the activity of looking at the future so as to anticipate and influence change.

2. FIRST STEPS OF ANALYSIS

What kinds of roles will computers play in the future? A natural first step toward answering this question is to look backward in time and trace the sudden developments of the computer since its inception less than 20 years ago. This will give us a feel for the rate at which computers have thus far influenced the fabric of society.

In the case of computers, there are a number of technological parameters which are indicative. Switching speeds and memory capacity have increased by three and four orders of magnitude. Reliability of components and overall systems has greatly increased. Costs have dropped dramatically. Programming languages have been developed which provide great flexibility so that now a non-expert can learn to use a machine with minimal training. And the professional programmer can now do his job faster and with greater accuracy due to new software developments. Highly diverse and sophisticated input and output equipment have been developed. And so on. These factors account, in no slight way, for the fact that computers have rapidly invaded so many facets of our society.

But coupled with these technological improvements have come a greater conceptual understanding of the nature of information processing and of the symbol manipulating power of contemporary machines, leading to a greatly expanded field of applications. Starting with strictly scientific (numerical) computing, the field has spread to business

data processing, real time control applications, information storage and retrieval uses, and so on. In less than 20 years the number of machines has grown to over 30,000; - associated with this growth has been the rise of a whole class of different professional computing societies, journals, meetings. And with these have come corresponding changes in education. Special advanced degree programs have been initiated in some of our leading universities.

Again, the purpose here is not to offer a survey of the field, but rather to indicate the kinds of items that would be relevant in such a survey. It is important in looking at the past and present to be sure that we are measuring the right kinds of parameters; i.e., those which are truly indicative of how computer usage will increase and be extended into new facets of our lives, and what are the ramifications which will influence the way our children will live.

3. NEXT STEP: SOME PROJECTIONS

How would experts in the field project into the future with respect to cost, speed, capacity, reliability, flexibility, and so on? How much bigger, faster, cheaper and more flexible will be the next generation of computers? And what can be extrapolated for five and ten years from today? Will most small businesses have modest computing facilities? Will they be tied to large central computers? Will there be a giant data processing utility with computer consoles in most private homes? What new R & D is on the horizon which may alter the computers of the future? Can past trends be extended? How will the introduction of

automation in the computing industry itself influence
cost and availability of future machines?

What about continuing software improvements? And
what of computer education? Will there be a computer in
every high school, and will every high school graduate
be familiar with computers and their uses? In what
direction will government use of machines be extended
and expanded? And what about computers in all facets of
state and local government? What tools and techniques
are needed to extrapolate from past trends to the near
and more distant future?

4. NEW AREAS OF APPLICATION

Aside from the continuing inroads into scientific
and business data-processing, what new information pro-
cessing situations will be automated in the future? We
can expect to see great gains in the use of computers in
education; i.e., new improved teaching machines. Computers
have already invaded hospitals, not only for record keeping,
financial as well as pharmacological, but as an aid in
diagnosis, for real-time monitoring of internal states of
a patient, for control during operations, etc. And the
general field of health and medicine is ripe for further
new types of computer applications.

The fields of law and criminology can be added to the
list of new areas of application. Data retrieval, question-
answering, and precedent searching are natural candidates
for automation.

Again, state and local governments, where recently
employment of clerks has been increasing to cope with the

exploding records management problem, will turn to computers
not only for cost reduction, greater record handling speed
and accuracy, but also for automatic report preparation.
Certain industrial production tasks will be further auto-
mated. Many current limitations hinge on purely economical
considerations; i.e., if it were economically feasible,
more tasks could now be fully automated. And it is getting
more economical to automate each year!

But clearly there are important conceptual problems
which currently block the road to further computer applica-
tions. What is the nature of these roadblocks? What
current research is aimed at removing these roadblocks? How
soon, for example, can we expect to have programs which will
permit machines to process ordinary language on the basis
of its subject content?

What are the other forces which influence how com-
puters will be introduced into completely new situations?
What motivates innovation and change in the computer field?
What constitutes inertia? What new skills are demanded in
order to make new inroads?

All of these questions, of course, raise other ques-
tions, but surely they indicate what is needed in order to
systematically explore the impact of computers on our future.

5. SOME GLIMPSES OF THE IMPACT

How will the increasing role of computers and automa-
tion influence our society and our lives? Several items
are readily apparent--at least we see the surface of the
problems. Computers are changing and will continue to
change the structure and content of our educational systems.

They will change what we teach as well as how we teach.
Because computers are changing the world so rapidly,
education for the future must include preparation for
change. Almost every profession, from medicine and law
to engineering and mathematics, is being influenced by
computers. How do we educate for participation in these
changing fields?

And what about those who cannot get the proper train-
ing? What about technological unemployment? This question
relates to questions concerning the state of our economy--
whether it will grow or not. And it relates to new social
institutions concerning the very nature of work and of our
attitudes toward forced unemployment. Can computers be
used to retrain those who have been displaced by machines?

And what will be the half-life of these new jobs--
how soon before they also become automated?

What will be the impact of computers on related
industries; e.g., the growing communications industry?
There will be a clear need for new and expanding types of
communication systems to cope with the growing need to
transmit information between people and remote machines,
and among geographically separate computing systems. How
will these two emerging giants, computers and communica-
tions, influence one another?

6. A CLOSER LOOK

In a deeper sense, where can we look to see the
possible impact of computers on our society? One method
of attack is to look at the basic characteristics of com-
puters and see what is implied when machines with these

properties invade a society. First of all, it is quite clear that we don't completely understand, in any really operational sense, what computers are; i.e., what they can do and how they are limited. Nevertheless, there are important things that can be said.

Let us look at the basic characteristics of machines and at their implications:

o   Computers operate at exceedingly high speeds. What does this imply? This means that if a high speed machine is used to control a complex situation, then it could compute an action to be taken and execute that action before a human could intervene. What are the potential dangers?

o   Computers, at least at present, demand extreme precision in their instructions. They take their instructions literally. Could there be a tendency to delegate a complex decision to a machine and find out that the machine did what we asked, but that it was not what we <u>wanted</u>--because we ourselves did not fully comprehend the fine structure of our own instructions? What are the full implications of this?

o   Computers have the capacity to handle large amounts of data. They can digest, analyze and relate these data in complete detail. If these data concern financial and personal information on people, what are the implications for the concept of privacy, for improper manipulation and control? What happens when large amounts of information about the economic and political aspects of a society are fed back to the citizens of that society? What is the influence of this information on the truth of the information? Can this type of information, when fed back, cause instabilities--economic and political? (Could the information flow--feedback, overload, and instability--be modeled?)

7. MACHINES VS. PEOPLE

Consider briefly what could happen as machines are used to make decisions about people. For example, consider a situation where a computer is programmed to decide: who should get a security clearance, or who should get an education loan, or whether someone's driver's license should be suspended, or who should get a passport, or who should be accepted for the Peace Corps, or the Job Corps, etc. As larger files become accessible there will be a natural tendency to use machines for the automatic selection (or rejection) of people according to some preprogrammed set of criteria. Supposedly these criteria will have been carefully thought out before programming the machine. Even so, it has dangerous implications. In such a mechanized situation, how does an individual get an opportunity to "tell the system" that its selection criteria don't hold for his own special case. Each individual is different, each is affected by extenuating circumstances, each has information that he believes to be relevant to the selection decision and which the system does not consider relevant. And so on. If an individual does not have the opportunity to be judged on the circumstances of his own special (individual) situation, then he is being treated as a machine!

8. THE QUESTION OF VALUES

Will there be a tendency in the future to mechanize our society in the sense that our use of computers tends to create an environment where we treat each other as machines; i.e., where there is no opportunity to "change

the system's mind"? How can we create a society where
we treat our citizens as people and not as machines? How
can we create a society where each individual has the
opportunity to explore and unfold his own potentials--to
realize what he is?

Again these questions lead to further questions--to
questions about who we are and what it means to be a person.
This brings us to the problem of values. What kind of a
life do we want? What kind would we value--ought we to have?
How can we create a society that fosters those actions and
goals that we value? How define, explicate values? How
measure and compare and rate values? How select among com-
peting values? How can we estimate the impact of computers
on our values?

The task of exploring the problem of computers and
their impact on the future of our society implies the task
of determining what values we want our society to foster,
and how a mechanized society will give rise to the social
structure we need to preserve our values.

And if our projections into the future suggest that
we are heading toward a future society which is not con-
ducive to a "good" life, what can be done to isolate the
trouble spots and to influence those changes that will
prevent the possible "evils"? The work of "future analysis"
implies prediction, evaluation, and then some attempt at
control. How can the control aspects be handled? Can the
process be made democratic so that a small professional
elite does not dominate in influencing the shape of the
future? These and other questions fall under the heading
of control.

Finally, there is the problem of time--the time that it takes to initiate and complete corrective action. Given an analysis of the impact of computers on society and given some corrective action that must be taken in order to avoid some future situation, how long will it take between the time the corrective action is taken and the time that the situation becomes properly modified. Some corrective actions would take too long and hence must be ruled out. At best we can say that events today are moving ahead very quickly indeed, and society is being changed at an accelerating pace. It is not too soon to begin actively to think about and prepare for the future.